

## 1. INTRODUCTION

At about GMT 2021-06-16, 167/12:11, NASA astronaut Shane Kimbrough and ESA (European Space Agency) astronaut Thomas Pesquet began a spacewalk that would last about 7 hours and 15 minutes. This was the seventh spacewalk of the year outside the International Space Station (ISS), where the two astronauts installed a new ISS Roll-Out Solar Array (iROSA) into its mounting bracket on the far end of the left (port) side of the station's backbone truss structure (P6). The EVA concluded with ingress by the two crew members at about GMT 19:26.

## 2. QUALIFY

The information shown in the spectrogram of Figure 1 was calculated from Space Acceleration Measurement System (SAMS) sensor 121f08 measurements made in the Columbus module with data spanning 3 days starting the day before the extravehicular activity (EVA). This plot focuses on the lower-frequency, structural mode and crew activity regime of the vibratory environment, including Urine Processing Assembly (UPA) operations near 3.7 Hz. Crew sleep periods are noted in white text, where we see broadband quieting (toward blue on color scale) below 6 Hz. This plot also shows increased structural vibration excitation contained between about GMT 12:11 and 19:26 as imparted by the crew working, pushing off, and landing on external structures of the space station. Note the heightened vibrations (red, horizontal streaks) during this EVA period primarily impacting below 2 Hz.

## 3. QUANTIFY

In order to quantify the impact of this EVA, we know to focus our attention below 6 Hz because this is the portion of the acceleration spectrum where the crew-induced forces are manifest. We use 10-second interval root-mean-square (RMS) values for 5 SAMS sensor heads distributed throughout the ISS to quantify and compare the impact at various sensor locations. For example, Figure 2 shows X-, Y-, and Z-axis interval RMS values (in units of  $\mu\text{g}$ ) for the same 3-day span as that of Figure 1. This shows the data for the sensor location most impacted by the EVA, the SAMS sensor mounted on COL1A3 in the Columbus module. For this plot and the other 4 sensors' plots of RMS acceleration values versus time shown starting with Figure 3 on page 2, the part of the traces in green represent crew sleep periods, the traces in red are for the EVA period, and the remaining black part of the traces are crew wake periods, but not during the EVA.

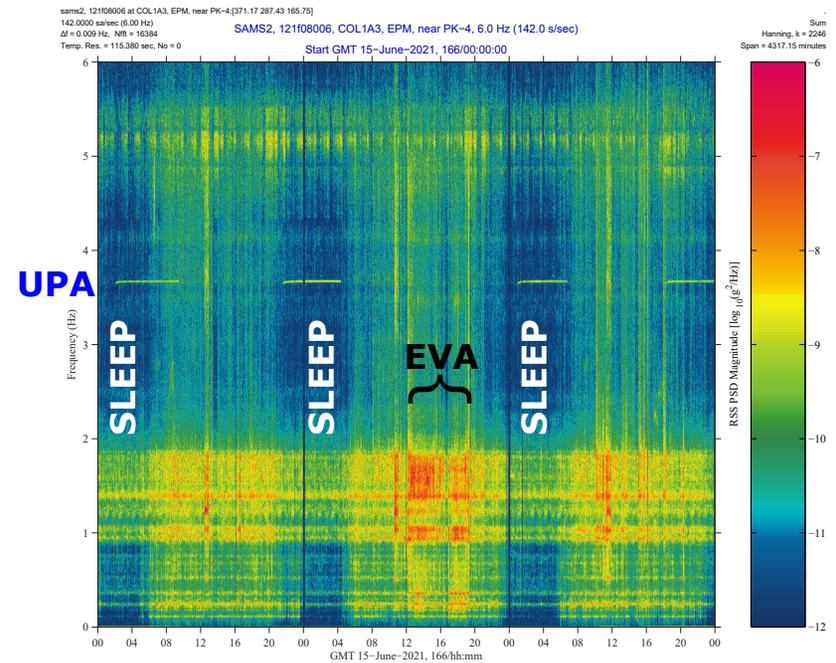


Fig. 1: Spectrogram for 3 Days Centered at EVA on GMT 2021-06-16.

## 4. CONCLUSION

The RMS values for the two SAMS sensors in Columbus show the largest impact due to EVA as highlighted in Table 1 on page 4. These show median interval RMS values for those 2 sensors plus 3 other sensors: 2 in the US Laboratory, and 1 in the Japanese Experiment module, Kibo.

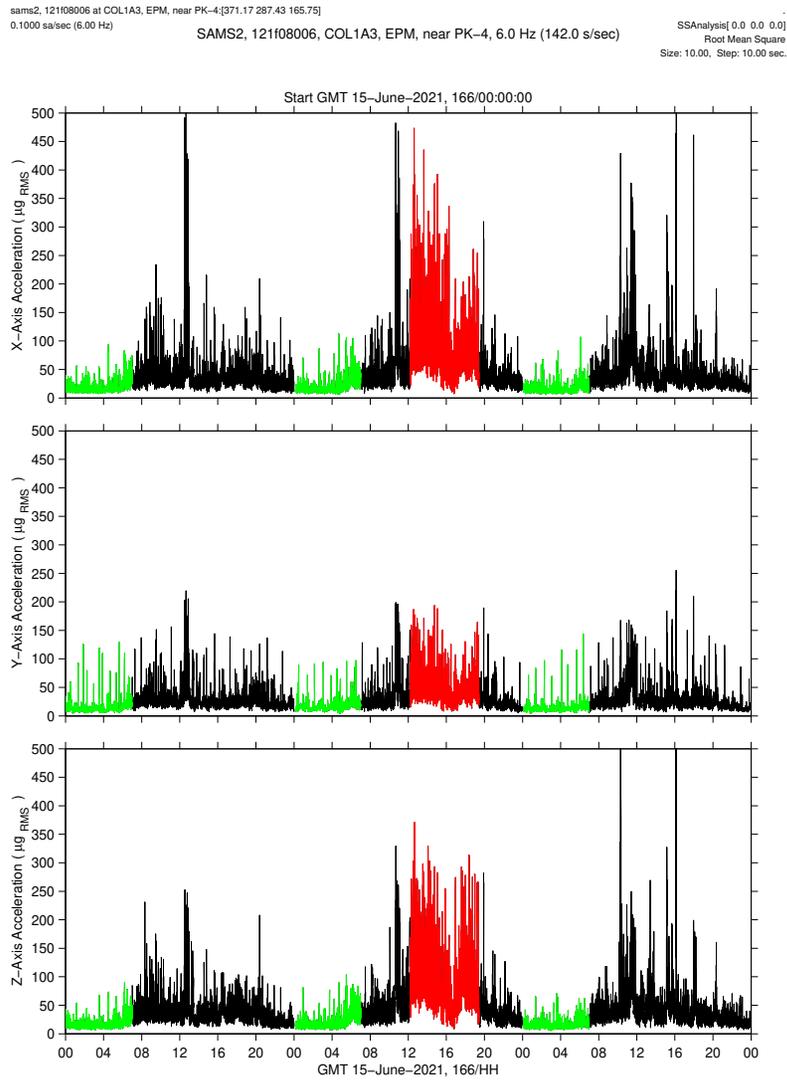


Fig. 2: RMS Below 6 Hz for SAMS 121f08 sensor in COL.

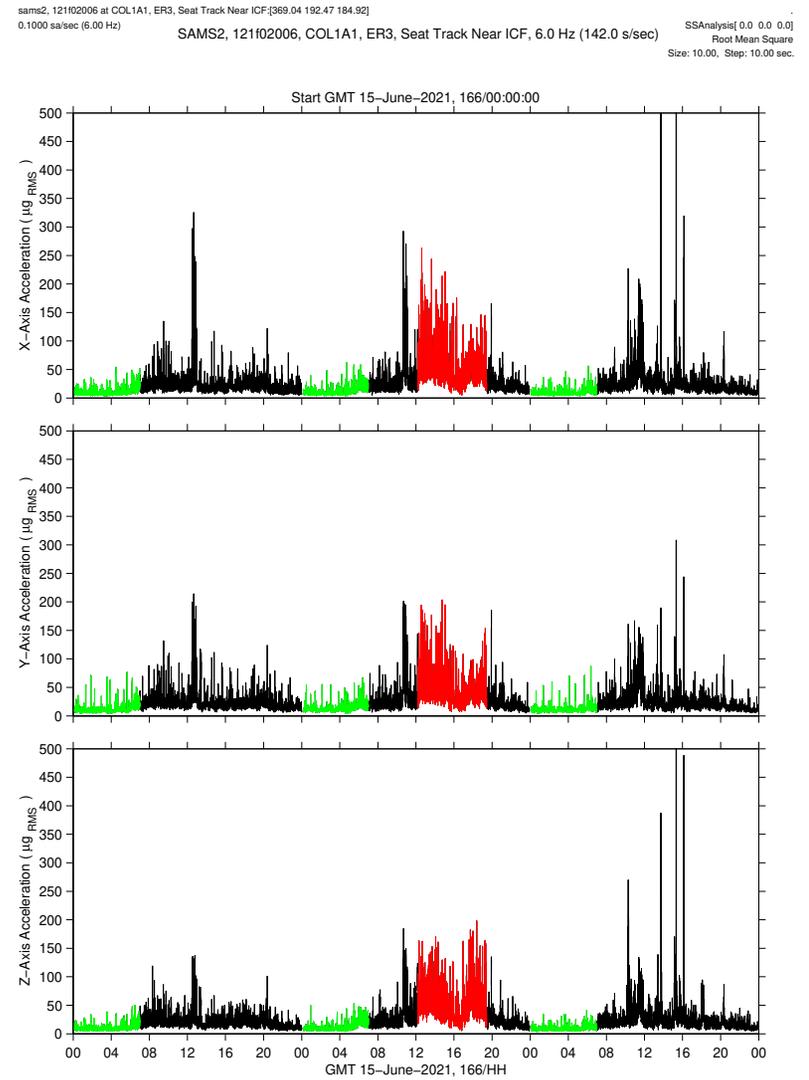


Fig. 3: RMS Below 6 Hz for SAMS 121f02 sensor in COL.

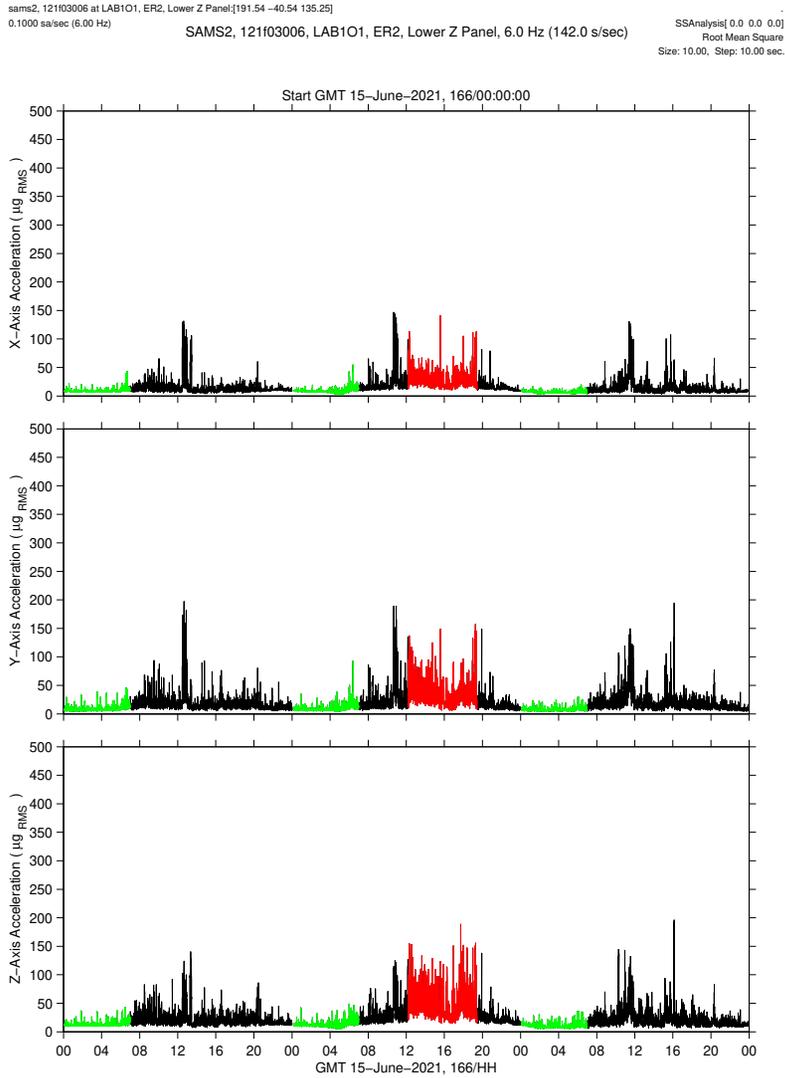


Fig. 4: RMS Below 6 Hz for SAMS 121f03 sensor in LAB.

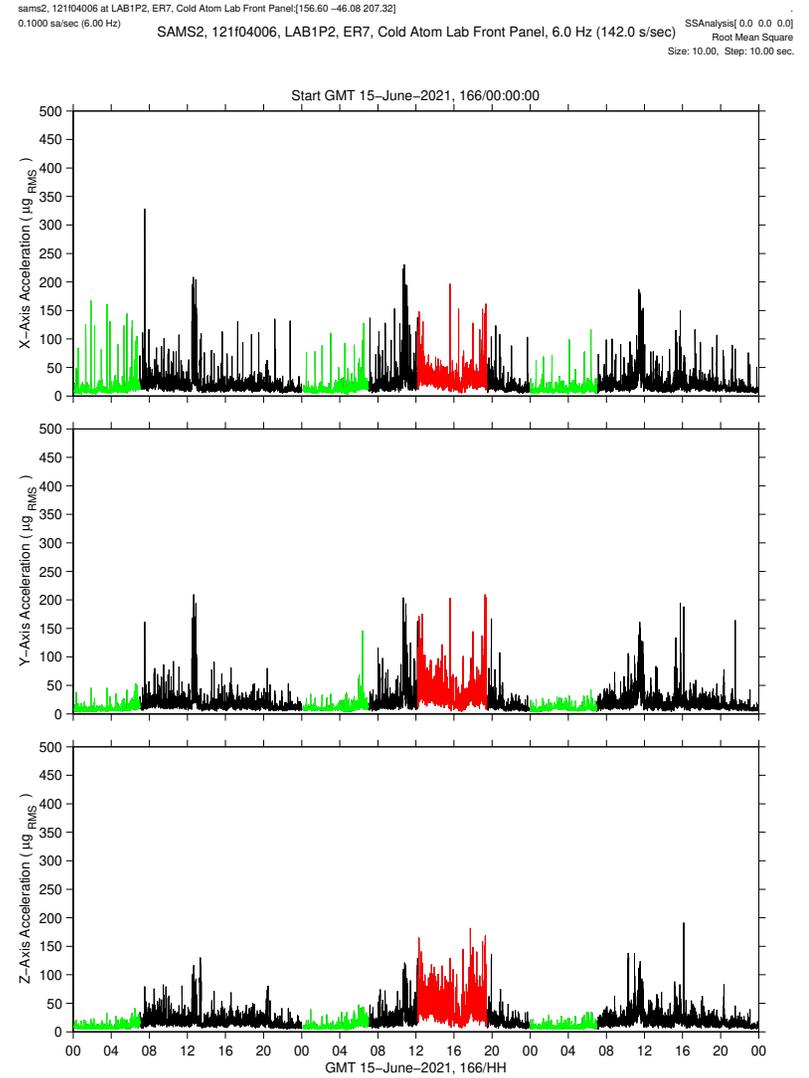


Fig. 5: RMS Below 6 Hz for SAMS 121f04 sensor in LAB.

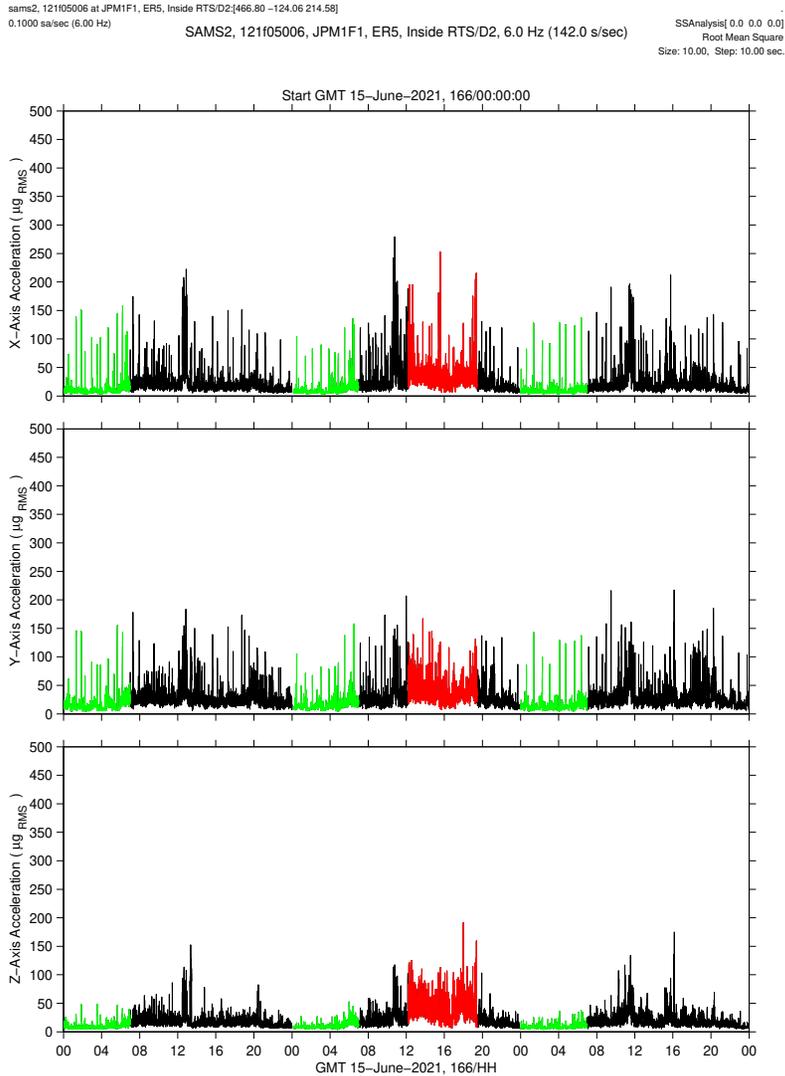


Fig. 6: RMS Below 6 Hz for SAMS 121f05 sensor in JEM.

Table 1. RMS Comparison EVA vs. Sleep vs. Wake, Non-EVA Periods.

| Space Acceleration Measurement System |          |      |               | Median Value (micro-g RMS below 6 Hz) |       |       |               |       |       |           |       |       |
|---------------------------------------|----------|------|---------------|---------------------------------------|-------|-------|---------------|-------|-------|-----------|-------|-------|
| SAMS                                  |          |      |               | SLEEP                                 |       |       | WAKE, NON-EVA |       |       | WAKE, EVA |       |       |
| Sensor                                | Location | Rack | Payload       | X                                     | Y     | Z     | X             | Y     | Z     | X         | Y     | Z     |
| 121f08                                | COL1A3   | EPM  | Near PK-4     | 14.95                                 | 12.39 | 15.06 | 31.28         | 21.51 | 31.91 | 80.89     | 42.84 | 83.64 |
| 121f02                                | COL1A1   | ER3  | Near ICF      | 8.46                                  | 10.19 | 8.88  | 19.00         | 18.82 | 18.72 | 49.47     | 41.41 | 48.57 |
| 121f03                                | LAB1O1   | ER2  | Lower Z-Panel | 7.81                                  | 7.18  | 11.24 | 11.29         | 13.86 | 18.02 | 26.12     | 30.79 | 44.60 |
| 121f04                                | LAB1P2   | ER7  | ColdAtomLab   | 10.35                                 | 7.94  | 8.02  | 15.39         | 14.25 | 16.01 | 28.17     | 31.84 | 40.88 |
| 121f05                                | JPM1F1   | ER5  | Inside RTS/D2 | 7.60                                  | 12.10 | 7.72  | 15.87         | 22.17 | 15.49 | 30.81     | 35.10 | 38.79 |